Effects of Canopy LAI, Crown Coverage, and View Angle on Retrieval of Leaf Chlorophyll Content in Forest Canopies

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In this study, we used simulated data created by SPRINT and PROSPECT to investigate issues on retrieval of leaf Chlorophyll content in sugar maple canopies. Two optical indices, the reflectance index R750/R710 and the derivative index D715/D710, were employed. As anticipated, these two indices have strong correlation with Chlorophyll content with R^2 over 0.99 at leaf level. At canopy level, for nadir observations, the correlation between the derivative index and leaf Chlorophyll content is 0.96 for canopies with crown coverage of 90, 75, 50 and 25 percent and canopy LAI of 4, while the correlation between the reflectance index and leaf Chlorophyll content is 0.50. Our results also show that the relationship between the derivative index and leaf Chlorophyll content derived from closed canopies can be used to predict the leaf Chlorophyll content for open canopies even for crown coverage of 25 percent with RMSE of 6.3 $\mu g/cm^2$. However, with the reflectance index, RMSE increases to over 15 $\mu g/cm^2$ when the relationship between the reflectance index and leaf Chlorophyll content is used for open canopies with crown coverage of 50 percent or less.

We also investigated the sensitivity of the derivative index to canopy LAI in this study. For nadir observations, the derivative index is sensitive to canopy LAI when canopy LAI changes from its nominal value of 4 down to a value of 2. Our results also show that the hotspot angle is the optimum angle to estimate leaf Chlorophyll content from the derivative index with the minimal effects of canopy LAI.

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